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NEW HAMPSHIRE

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BULLETIN NO. 8.

FEEDING EXPERIMENTS.

PART 1.—PRINCIPLES OF FEEDING.

PART 2.—CORN MEAL, MIDDLINGS, SHORTS AND COTTON SEED COMPARED.

NOVEMBER, 1889.

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— OF THE —

NEW HAMPSHIRE

Agricultural Experiment Station.

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FEEDING EXPERIMENTS.

PART I.

The object of this bulletin is to place in the hands of the New Hampshire farmer, a brief statement of some of the experiments made during the winter of 1888–9, for the purpose of determing the the feeding value of various fodders and grains, in the production of milk and butter, and as the period of winter feeding is at hand, I have thought best to give in condensed form, the principles and laws which are at the bottom of successful, practical stock feeding showing how these laws find expression in which are called "Feeding Standard." The tables given are a reprint of those in Bulletin No. 4 of this station; Their use though exceedingly simple, is, nevertheless a key to successful practical feeding, and no farmer in the state who has stock to feed can afford to neglect the teachings of these tables for by their use the cost of production of milk, on an average, may, in my opinion, be reduced one fifth from the present figures any such estimate must be a matter of opinion but it is true in all lines of manufacture that the substitution of exact, in place of hap-hazard methods, of demonstrated laws instead of guesses, invariably reduces the cost of the manufactured article, and the production of milk beef or pork is no exception to this.

Rational methods in stock feeding depend upon two things. First, we must know what a given animal requires daily. Second, we must have some means of knowing where and how to get these materials in the right quantity and proportion. These two requirements are satisfied by tables I and II.

WHAT THE TABLES ARE

Table I, called "Feeding Standards," tells us at a glance how much digestible material is *required* daily for 1000 lbs. live weight for the various animals under the several conditions mentioned. This table originated in Germany and represents the average of a great number of carefully conducted practical tests in which the food was weighed, and samples of it analysed and its digestibility determined. It is very reasonable to suppose that these results are, in the main, reliable and accurate,

TABLE I. GERMAN "FEEDING STANDARDS."

1,000 lbs. of live weight required daily.	Digestible substances. Albuminoids. lbs.	Non-albuminoids. lbs.	Nutritive ratio.
Oxen, at rest,	0.7	8.37	1:12
Oxen, moderately worked,	1.6	12.05	1: 7.5
Oxen, heavily worked,	2.4	14.45	1: 6
Oxen fattening,	3.0	16.55	1: 5.5
Cows, giving milk,	2.5	13.50	1: 5.4
Horses, light driving,	1.8	12.70	1: 7
Horses, heavily worked,	2.8	15.4	1: 5.5
Growing cattle,	2.5	15.0	1: 6
Sheep, for wool,	1.2	10.8	1: 9
Sheep, fattening,	3.0	16.45	1: 5.5
Swine, fattening,	4.0	24.0	1: 6

TABLE II. COMPOSITION OF "FEEDING STUFFS."

Herdsgrass, (timothy) hay	3.45	48.71	1:14
Redtop hay,	4.74	48.19	1:10
Mixed hay,	3.71	47.61	1:12.8
Mixed hay and clover,	4.85	46.40	1: 9.5
Salt marsh hay,	2.27	45.83	1:20
Clover hay,	7.53	43.60	1: 5.7
Vetch hay,	9.20	37.67	1: 4
Oat hay,	4.85	44.83	1: 9.2
Winter rye hay,	10.3	51.7	1: 5
Millet hay,	4.67	45.43	1: 9.7
Rowen,	6.81	41.74	1: 6.1
Oat straw,	1.45	43.31	1:30
Bean vines,	5.00	36.45	1: 7.3
Corn stover,	2.15	41.38	1:19
Ensilage, (northern corn),	1.47	14.80	1:10
Ensilage, (southern corn),	1.32	12.73	1: 9.6
Ensilage, (sweet corn),	1.84	14.92	1: 8
Pasture grass,	2.5	10.9	1: 4.4
Green rye,	2.00	12.87	1: 6.4
Potatoes,	1.42	17.70	1:12.4
Sugar beets,	1.5	7.81	1: 6.5
Corn and cob meal,	7.13	66.52	1: 9.3
Corn meal,	7.78	71.60	1: 9.2
Barley meal,	9.54	65.95	1: 6.9
Oats, ground,	9.90	58.16	1: 5.9
Buckwheat, ground,	7.7	66.71	1: 8.7
Linseed, (old process),	28.12	53.21	1: 1.9
Linseed, (new process),	28.57	44.30	1: 1.5
Cotton seed meal,	31.36	42.26	1: 1.3
Shorts,	13.26	52.70	1: 4
Middlings,	13.35	57.72	1: 4.3
Gluten,	25.14	61.90	1: 2.4
Brewers' grains, (wet)	4.73	16.22	1: 3.4
Malt sprouts,	18.36	52.18	1: 2.8

that variations from them are some times profitable is well known and from the work that has been done in our own country it would seem that the proportion of non-albuminoids (starch, sugar; fat etc.,) to albuminoids might well be made less than the tables indicate, but the fact that we may depart in a small way from these tables does not in the least reduce their value as *guides* to *good feeding.*

The column headed *digestible albuminoids* includes that part of the food which contains the nitrogen of the plant. It will be noticed that the per cent of albuminoids vary greatly in different fodders. In *dry* fodders, oat straw has only 1.45 pounds in a hundred while cottonseed meal has 31.36. Hay and the dry fodders commonly found on the farm have about 5% of digestible albuminoids while the grains and concentrated feeding stuffs run from 7 to 35%. It must be remembered that this part of the food is very valuable, for the muscle of the growing animal, the casein or curd of the milk, wool, feathers, hair, etc., must be formed from the albuminolds of the food. Neither starch, sugar nor oil can be converted into muscle or casein by the animal. It is also believed that the fat in the milk or the other fat in the body comes quite largely from the albuminoids, but fat may also come from the starch, sugar, and oil of the food. The column marked "digestible non-albuminoids" includes the starch, sugar, and fiber, plus the fat, multiplied by 2½, for it is assumed that one pound of fat is equal in nutritive value to 2½ pounds of starch, by this arrangement we get the whole of the nutritive matter of the food grouped in two parts. The third column shows the ratio of non-albuminoids to albuminoids for example corn meal has 7.78% of albuminoids and 71.6% of non-albuminoids the "nutritive ratio" is 1 : 9.2 which is the same as saying that for every pound of the former, there are 9.2 pounds of starch, sugar, and fat (non-albuminoids).

In these tables then we have the means of finding the amount of nutritive matter require daily by any animal: the live weight of any animal being known we have only to look in table I, and find the corresponding kind of animal, the table will show what would be required if the live weight were 1000 lbs., from this we find the amount necessary for any weight by multiplying that necessary for 1000 by the weight under consideration and remove the decimal point three places to the left. Example: Given a cow weighing 1185 pounds, and producing milk

what amount of albuminoids and non-albuminoids will be required daily? Table I, shows that cows giving milk require 2.5 lbs., of albuminoids and 13.5 lbs., of non albuminoids daily per 1000 lbs., $2.5 \times 1185 = 2962.5$ remove point three places to the left $= 2.96$ lbs., of albuminoids required. $13.5 \times 1185 = 15997.5$ remove point three places $= 15.99$ lbs., non-albuminoids required. The same rule applied under any condition or for any weight will give "amount required."

The second step is to select from table II such fodders and grains as will give this amount, here is where the skill of the feeder is required in selecting a suitable variety. If hay is the foundation use 1½% of the live weight of the animal of hay, that is for a 1000 lb., animal use about 15 lbs.. of hay, and in addition to this 1% or 10 lbs., of any coarse fodder like corn stover (corn stalks from which ears have been husked) well cured straw, rye cut for fodder, millet, or bean vines.

Where Ensilage is to be fed, take 5% of the live weight of the animal of Ensilage that is for a 1000 lb., animal, 50 lbs., and add to this ½% or 5 lbs,. of coarse fodder, these two combinations may be regarded as foundations to which the grain ration is to be fitted. Our coarse fodders, hay and ensilage, all with two or three exceptions, contain much too large a percentage of non-albuminoids to meet the requirements of cows. Oat straw has 30 lbs., of digestible non albuminoids to 1 of albuminoids, (see third column table II) cornfodder has a "nutritive ratio" of 19, bog meadow, or swale hay 20. Hedrsgrass 14, red top 10, millet 9.7 etc., now from table I, we see, leaving out animals standing idle, that our different domesticated animals require from 5.4 to 9 pounds of non albuminoids to 1 of albuminoids, here is where the tables show us the deficiency of such fodders: To make good this deficiency we must look for some material that has an *excess* of the *albuminoids;* running down column three in table II, linseed, cotton seed, shorts, middlings and gluten are seen to have nutritive ratios as follows respectively, 1.5, 1.3, 4, 4.3, 2.4 now here are a class of foods as much too rich in the muscle producing part of the food as the coarse fodders and hay are too poor hence a judicious mixture of one set with the other will correct the deficiencies of each but how shall we know the proportion in which to mix them. We have seen that a cow weighing 1000 lbs. giving milk requires daily the following:

Digestible Albuminoids, 2.50 lbs.,
Digestible Non-albuminoids, 13.50 lbs.,

We will next see what our two "foundations" furnish, from Table II it is easily figured that:

	Digestible. Albuminoids. lbs.	Non-albuminoids. lbs.
15 lbs., mixed hay and clover, furnish,	.56	7.14
10 bs corn stover, furnish,	.22	4.14
Total furnished,	.78	11.28
Total required,	2.50	13.50
Deficiency to come from grain,	1.72	2.22

The following will give a ration near enough to the standard.

Cottonseed 4 lbs., = 3 qts., =	1.26	1.68
Shorts, 2 lbs., = 3 qts., =	.26	1.04
Middlings, 1 lb., = 1 qt., =	.13	.57
	1.65	3.29

Putting this ration together we get the following:

	lbs.	qts.	Albuminoids	Non-albuminoids
Hay,	15		56	7.14
Corn stover,	10		22	4.14
Cottonseed,	4	2½	1.26	1.68
Shorts,	2	3	.26	1.04
Middlings,	1	1	.13	.57
	7	6½	2.43	14.57
Required by standard,			2.50	13.50

This ration has a nutritive ratio of 1:6 which is as narrow as we can afford to go.

Our second "foundation" figures as follows:

	lbs.	qts.	Albuminoids.	Non-albuminoids.
Ensilage,	50		.74	7.40
Millet,	5		.23	2.27
Gluten,	2	3	.75	1.85
Middlings,	4	3½	.54	2.30
Shorts,	1	1½	.13	.52
			2.39	14.34

Computing and balancing rations by the aid of the tables requires nothing but simple arithmetical calculations, which any feeder in the state can make if he will and while many will find that by years of observation in the barn they have hit upon

rations which the use of these tables cannot better, yet the probability is that three-fourths would find by a very few minutes of figuring that they have been feeding too much of the non-albuminoids, in many cases the nutritive ratio is as wide as 1 : 12. As a rule we are too liberal in our use of corn meal which in itself is lacking in albuminoids, but which is too often fed with foods much more deficient in this same direction.

If the foundation of our rations for milk was clover hay, then we might well depend upon corn meal for our grain ration, but with fodders whose nutritive ratio is from 10 to 20, that is, has 10 to 20 times as much digestible starch, sugar, fat etc., as of albuminoids, it is poor economy to buy corn meal when there are so many kinds of fodders in the market, like cotton seed, gluten, linseed, middlings and shorts, which are rich in just those parts in which the hay, ensilage, corn fodder, etc., are lacking. If the farmers of this state would buy less corn meal and more of the foods above mentioned a considerable saving might be brought about in the cost of the ration, for the reason that with these foods much of the straw, swale hay and other coarse fodders might be substituted in place of the English hay which it is now necessary to feed. By way of illustrating this I will give two rations, which will show the force of what has been said

No. 1.

	lbs.	qts.	Albuminoids	Non-albuminoids.
Mixed hay,	25		.93	11.9
Corn meal,	6	8	.48	4.2
			1.41	16.1
Required by German standard,			2.50	13.5

No. 2.

Mixed hay,	10		.37	4.76
Swale hay,	10		.22	4.58
Cotton seed,	4	3	1.26	1.68
Shorts,	2	3	.26	1.04
Middlings,	3	2½	.40	1.73
Furnished,			2.51	13.79
Required by German standard,			2.50	13.50

If we call the average value of market hay in New Hampshire $15, per ton Swale hay $8. Cottonseed $25, Corn meal $20, Middlings $22, and Shorts $20 ration No. 1, will cost 25 cents while No. 2 will cost 22 cents, now it will be seen at once that No. 2

furnishes a full ration, with the parts well proportioned for milk production while No. 1 is lacking in albuminoids by more than one pound but has an excess of non-albuminoids, the nutritive ratio of No. 1 is 1 : 11.4 while No. 2 is 1 :5.5. It is evident that the second ration is much better adapted for milk production than the first and would undoubtedly give a better yield.

I would call the attention of our stock feeders, to the one point of *feeding well proportioned or "balanced" rations*, and in this connection, would suggest that the "feeding standards" and table of "Feeding stuffs" are guides which if followed will give this suitable proportion of parts in the rations we feed our stock, now if any one is already feeding such a ration the satisfaction of knowing this will amply repay the little trouble there is in calculating the exact amount of nutritive matter fed; if, on the other hand the present practice does not, within reasonable limits, correspond with the German standards, then no harm can come from modifying the grain or fodder and noting whether there is actually any increase of product or decrease of cost for it is by this measure of dollars and cents that we must finally prove that one ration is better than another.

I have intimated that some variation from the German standard is even desirable in our practice and I am of the opinion that if we get the "nutritive ratio" any where between 6 and 7 we shall still have a well balanced ration.

PART II.

CHEMICAL ANALYSIS OF MATERIALS USED IN FEEDING EXPERIMENTS, WINTER OF 1888–89.

These analyses were made by Mr. F. W. Morse, now Station Chemist. The grains were bought in local markets and the hay was raised on the Station farm.

The analyses show the per cent of water, dry substance, ash, crude protein, nitrogen free extract, (including starch, sugar etc.,) ether extract, or crude fat, and crude fiber; the column showing this is headed "% in original substance." The next column shows the same computed as per cents of the dry substance instead of the original substance next comes per cent of digestible matter in the original substance, this is dervied from the total composition by taking the average digestibility of similiar foods as given by Goessman and others.* This column shows just how

*Massachusetts Agricultural Experiment Station, Annual Report 1887.

much useful material there is in each substance, for it is the *digestible* part of the food that determines its value for feeding

TABLE III. EARLY CUT HAY. (Cut July 10, 1888.)

	Total composition.		Amount digestible in original substance	Digestible.		Nutritive ratio.
	Original substance.	Dry substance		Albuminoids.	Non-albuminoids.	
Moisture at 212°,	12.10					
Dry substance,	87.90					
Crude ash,	3.59	4.09				
Crude protein,	7.19	8.18	4.10	*4.10*	*48.45*	*1:11.8*
Nitrogen free extract,	49.14	55.90	30.95			
Crude fiber,	25.70	29.24	14.90			
Ether extract,	2.28	2.59	1.04			
LATE CUT HAY. (Cut July 31, 1888.)						
Moisture at 212°,	8.63					
Dry substance,	91.37					
Crude ash,	4.34	4.75				
Crude protein,	7.68	7.75	4.04	*4.04*	*50.34*	*1:12.4*
Nitrogen free extract,	50.83	55.63	32.02			
Crude fiber,	26.56	29.07	15.46			
Ether extract,	2.56	2.80	1.17			
CORN MEAL.						
Moisture at 212°	13.90					
Dry substance,	86.10					
Crude ash,	1.50					
Crude protein,	10.17	11.81	8.64	*8.64*	*72.94*	*1: 8.4*
Nitrogen free extract,	68.37	79.40	64.26			
Crude fiber,	1.81	2.10	.61			
Ether extract,	4.25	4.94	3.23			
MIDDLINGS.						
Moisture at 212°,	12.47					
Dry substance,	87.53					
Crude ash,	3.33	3.81				
Crude protein,	19.96	22.81	17.56	*17.56*	*52.86*	*1: 3*
Nitrogen free extract,	57.17	65.30	45.73			
Crude fiber,	3.89	4.45	.78			
Ether extract,	3.18	3.63	2.54			
SHORTS.						
Moisture as 212°,	12.29					
Dry substance,	87.71					
Crude ash,	6.21	7.08				
Crude protein,	17.85	20.35	15.71	*15.71*	*50.74*	*1: 3.2*
Nitrogen free extract,	49.97	56.97	39.97			
Crude fiber,	9.21	10.50	1.84			
Ether extract,	4.47	5.10	3.57			
COTTON SEED MEAL.						
Moisture at 212°,	8.86					
Dry substance,	91.14					
Pure ash,	5.81	6.39				
Crude protein,	46.32	50.82	34.27	*34.27*	*32.70*	*1: .9*
Nitrogen free extract,	23.68	25.97	10.89			
Crude fiber,	6.38	7.00	1.40			
Ether extract,	8.95	9.82	8.14			
GLUTEN.						
Moisture at 212°,	10.52					
Dry substance,	89.48					
Ash,	.70					
Crude protein,	29.70	33.20	25.24	*25.24*	*58.21*	*1: 2.3*
Nitrogen free extract,	54.99	61.34	51.60			
Crude fiber,	.81	.91	.21			
Ether extract,	3.37	3.77	2.56			

purposes; The next column gives this same digestible matter grouped into albuminoids, and non albuminoids. The early and late cut hay were nearly clear Timothy or Herdsgrass the former cut July 10 just as it was going out of bloom the latter cut July 31, the seed being well filled but not hard; it must be remembered that the season of '83 was very wet and grass was from 8 to 10 days behind its ordinary time of blooming and maturity.

It will be noticed that these analyses vary in some cases from those of similiar foods in table II but the variations are not very wide. The following table shows in condensed form the analyses above given in detail.

	Digestible Substance		
	Albuminoids	Non-albuminoids	Nutritive Ratio.
Early cut hay (Timothy),	4.10	48.45	1 : 11.8
Late cut hay (Timothy),	4.04	50.34	1 : 12.4
Corn meal,	8.64	72.94	1 : 8.4
Middlings,	17.56	52.86	1 : 3.0
Shorts,	15.71	50.74	1 : 3.2
Cotton seed meal,	34.27	32.70	1 : 0.9
Gluten,	25.24	58.21	1 : 2.3

Table IV gives the full details of an experiment comparing corn meal, cotton seed meal, and shorts. The rations in each case were richer in albuminoids than is believed to be necessary, but it will be noticed that those in which corn meal is used are in strict accord with the "German Standards," and that the substitution of cotton seed for corn meal reduced the ratio from 5.5 to 4.5 on an average, which is a very narrow ratio. The object of this experiment was to determine, if possible, whether an increase in albuminoids would increase the yield of milk. Table IV shows the number of the period and the number of days in each period, as well as the dates. The name of the cow and her breed is given in the left hand column, next comes the kind of food used in the ration, and in the third column the amount of each substance fed daily, together with the nutritive ratio of the food, while at the bottom of this column is the amount of milk produced per period and per day; the fourth, fifth and sixth columns are repetitions of the third, except that changes from corn meal to cotton seed, and the reverse, occur; next comes the total milk for each cow for the *whole* time she was in the experiment, followed by two colums dividing this total into two parts, one produced while *corn meal* was fed, the

TABLE IV.

		PERIOD.									
		14 Mar. 11 to Mar. 25.	15 Mar. 25 to Apr. 8.	16 Apr. 8 to Apr. 22.	17 Apr. 22 to May 6.					Per day.	Nutritive ratio
		lbs.	lbs.	lbs.	lbs.		lbs.	lbs.	lbs.	lbs.	
Northboro Belle. (Holstein.)	Ensilage,	60	60	60	60	Milk produced "corn meal" periods,		779.8		27.82	
	Rye Hay,	5	5	5	5	Milk produced "cotton seed meal" periods,		724.8		25.86	
						Daily excess in favor of co ton seed meal,				1.96	
	Shorts,	2	2	2	2		Albu-	Non-			
	Corn Meal,	2		2		Rations contained.	minoids.	Albu'ds	Total.		
	Cotton Seed Meal,		2		2	Corn meal ration,	2.90	16.27	19.17		1 : 5 6
	Gluten,	4	4	4	4	Cotton seed ra ion,	3.41	15.46	18.87		1 : 4.5
	Milk per period,	408.13	363.56	371.72	361.29						
	Milk per day,	29.15	25.97	26.55	25.81						
Duchess. (Durham.)	Ensilage,		50	50		Milk produced "corn meal" periods,		149.56		10.68	
	Rye hay,		5	5		Mild produced "cotton seed meal" periods,		151.64		10.83	
						Daily excess in favor of cotton seed meal,				.15	
	Shorts,		2	2			Albu-	Non-			
	Corn Meal,		2			Rations contained.	minoids.	Albu'ds.	Total.		
	Cotton Seed Meal,			2		Corn meal ration,	2.75	14.79	17.54		1 : 5.4
	Gluten,		4	4		Cotton seed ration,	3.26	13.98	17.24		1 : 4.3
	Milk per period,		149.56	151.64							
	Milk per day,		10.68	10.83							
Colinka. (Holstein.)	Ensilage,			60	60	Milk produced "corn meal" periods,		188.68		13.48	
	Rye hay,			10	10	Milk produced "cotton seed meal" periods,		189.50		13.54	
						Daily excess in favor of cotton seed meal,				.06	
	Shorts,			2	2		Albu-	Non-			
	Corn Meal,			2		Rations contained.	minoids.	Albu'ds.	Total.		
	Cotton Seed Meal,				2	Corn meal ration,	3.42	18.85	22.27		1 : 5.5
	Gluten,			4	4	Cotton seed meal,	3.93	18.05	21.98		1 : 4.6
	Milk per period,			188.68	189.50						
	Milk per day,			13.48	13.54						

TABLE IV.—(Continued.)

		PERIOD.									
		14 Mar. 11 to Mar. 25.	15 Mar. 25 to Apr. 8.	16 Apr. 8 to Apr. 22.	17 Apr. 22 to May 6.					Per day.	Nutritive ratio
		lbs.	lbs.	lbs.	lbs.		lbs.	lbs.	lbs.	lbs.	
Maranne. (Holstein.)	Ensilage,		60	60		Milk produced "corn meal" periods,		422.24		30.16	
	Rye hay,		5	5		Milk produced "cotton seed meal" periods,		456.99		32.69	
						Daily excess in favor of cotton seed,				2.48	
	Shorts,		3	3			Albuminoids.	Non-Albu'ds.	Total.		
	Corn Meal,					Rations contained.					
	Cotton Seed Meal,		2	2		Corn meal ration,	2.80	16.19	18.99		1 : 5.8
	Gluten,		3	3		Cotton seed ration,	3.31	15.39	18.70		1 : 4.6
	Milk per period,		456.99	422.24							
	Milk per day,		32.04	30.16							
Gleam. (Holstein.)	Ensilage,			50	50	Milk produced "corn meal" periods,		369.67		26.41	
	Rye hay,			5	5	Milk produced "cotton seed meal" periods,		390.13		27.87	
						Daily excess in favor of cotton seed,				1.46	
	Shorts,			2	2		Albuminoids.	Non-Albu'ds.	Total.		
	Corn Meal,			2		Rations contained.					
	Cotton Seed Meal,				2	Corn meal rations,	2.75	14.79	17.54		1 : 5.4
	Gluten,			4	4	Cotton seed rations,	3.26	13.98	17.24		1 : 4.3
	Milk per period,			369.67	390.13						
	Milk per day,			26.41	27.87						
Catones Pink. (Jersey.)	Early cut hay,			15	15	Milk produced "corn meal" periods,		142.38		10.17	
	Rye hay,			5	5	Milk produced "shorts" periods,		139.43		9.95	
						Daily excess in favor of corn meal,				.22	
	Shorts,			2			Albuminoids.	Non-Albu'ds.	Total.		
	Corn Meal,			2	2	Rations contained.					
	Gluten,			2	2	Corn meal ration,	1.98	14.09	16.07		1 : 7.1
	Milk per period,			139.43	142.38	Shorts ration,	2.13	13.65	15.78		1 : 6.4
	Milk per day,			9.95	10.17						
Princess Leto. (Jersey.)	Ensilage.	45	45	45	45	Milk produced "corn meal" periods,		507.07		18.11	
	Hay,	5	5	5	5	Milk produced "shorts" periods,		494.36		17.65	
						Daily excess in favor of corn meal,				.46	
	Shorts,	2	2	2	2		Albuminoids.	Non-Albu'ds.	Total.		
	Corn Meal,					Rations contained.					
	Gluten,	3½	3½	3½	3½	Corn meal ration,	1.92	12.67	14.59		1 : 6.6
	Milk per period,	256.50	247.73	246.63	250.57	Shorts ration,	2.06	12.22	14.28		1 : 5.9
	Milk per day,	18.32	17.69	17.62	17.90						

other while *cotton seed* was in the ration; the last two columns show the gain of milk occasioned by changing from one grain to the other. When the corn meal gives the greatest yield the excess is put in column marked "corn meal," and when cotton seed meal gives best results the gain is found in the column headed "cotton seed meal."

These five cows, when on corn meal, produced daily 108.55 pounds of milk, and when on cotton seed 110.74, a gain of 2.19 pounds, which is .44 of a pound per cow per day. This is too small an amount to be of any great value in getting at the relative efficiency of the two rations, but it will be noticed that in only one case is there an excess on the corn meal side, while in two cases there is practically no difference, the two remaining cows showing a very substantial increase due to the cotton seed.

There is another point which should be considered, though no definite correction can be applied. In four cases the corn preceded the cotton seed, and in one case (that of Maramee) the cotton seed came first, and as all of the cows were naturally shrinking in milk yield, it follows, that in four cases the cotton seed is shown at a disadvantage equal to this shrinkage, while in one case the corn meal loses in the same way. Northboro Belle unquestionably did better on the corn meal than on the cotton seed, while Maramee and Gleam gave evidence just the opposite.

The total digestible matter, that is, the sum of the Albuminoids and non-albuminoids, is somewhat less in the cotton seed than in the corn meal ration; the average for the five cows is 18.81 pounds daily with cotton seed, and 19.10 pounds with corn meal, but it is also true that as the market averages the cotton seed ration costs about three mills more per day than the other. Taking all the facts as they stand, the following conclusions seem warranted:

First. Narrowing the nutritive ratio from the German standard of 5.4 to 4.5 does not *materially* increase the amount of milk.

Second. It appears that under the conditions of the experiment, a *pound of digestible matter* was slightly more efficient in the narrow than in the wide ration.

Third. We must not lose sight of the fact that the manure from the cotton seed ration must have been more valuable, for the reason that corn meal contains only one-half as much phosphoric acid, one-third as much potash, and one-third as much

nitrogen, as does cotton seed meal. This becomes an important matter when we consider the field work as well as our feeding.

CORN MEAL COMPARED WITH SHORTS.

From this table it is seen that the two cows produced daily, when on the corn meal ration, 28.28 pounds, and on the shorts, 27.60 pounds, a gain of .68 of a pound in favor of corn meal, or .34 of a pound for each cow. The dry matter in the rations is slightly less with the shorts than with the other, while the cost of the ration is the same. In this experiment the cow Pink was giving a very uniform quantity of milk and had been shrinking very little for two months, while Princess Leto was so fed that the shrinkage, provided it was uniform from period to period, would not work to the disadvantage of either ration; it is probable, therefore, that the shorts were actually of less feeding value than the meal.

TABLE V.

		PART 1.			PART 2.		
		*9	10	11	16	17	†18
		Dec. 24 to Jan. 14.	Jan. 14 to Jan. 28.	Jan. 28 to Feb. 11.	Apr 8 to Apr. 22.	Apr. 22. to May 6.	May 6 to May 13.
Nora 2nd. (Durham.)	Early hay,	25	25	25			
	Ensilage,				50	50	50
	Corn Meal,	2	2	2	2	2	2
	MIDDLINGS,	〃	〃	〃	〃		
	SHORTS,	〃				〃	〃
	Gluten,	3	3	3	3	3	3
		587.03	387.27	379.07	332.25	326.09	161.51
		27.95	27.66	27.08	23.73	23.29	23.07

*Period 9 was of 21 days instead of 14. †Period 18 was for 7 days instead of 14.

The experiment recorded in table V must be divided into two parts, as there was an interval of four periods devoted to other work with the same cow.

Part 1, 21 days on *shorts*, the yield was 587.03, or 27.95 daily.
Part 1, 28 " *middlings*, " 766.34, or 27.37 "

Daily excess in favor of shorts, .58

Part 2, 14 days on *middlings*, the yield was 332,25, or 23.73 daily.
Part 2, 21 " *shorts*, " 487.60, or 23.22 "

Daily excess in favor of middlings, .51
Or averaging the two parts, the middlings gave 25.55 "
The shorts gave 25.58 "

The composition of the two rations was:

		Albuminoids.	Non-Albuminoids.	Total.	Nutritive ratio.
Shorts,	Part 1,	2.27	16.58	18.85	1 : 7.3
Middlings,	Part 1,	2.30	16.61	18.91	1 : 7.2

		Albuminoids.	Non-Albuminoids.	Total.	Nutritive ratio.
Shorts,	Part 2,	1.98	11.62	13.60	1 : 5.9
Middlings,		2.02	11.65	13.67	1 : 5.7

This experiment shows, like the other, that a change of grain, so long as there is no wide departure in the digestible matter, does not materially affect the results, and as the above rations were compounded, the shorts are as effective as the middlings, but the cost is less by about one-cent daily with the shorts.

GLUTEN COMPARED WITH MIDDLINGS.

A single experiment with *gluten* and *middlings* resulted as follows:

Nora 2nd. (Durham.)		
Late cut hay,	20	20
Cured oats,	5	5
Corn meal,	2	2
Middlings,	2	
Gluten,		2⅛
Shorts,	2	2
Milk per day,	25.59	27.62
Dry matter in ration,	17.71	18.07
Nutritive ratio,	1 : 8.4	1 : 7.7

In this case there is an unmistakable gain in favor of the gluten meal. The amount used was such that the cost of the rations was identical.

GLUTEN COMPARED WITH SHORTS.

Countess Gazelle. (Jersey.)		
Hay,	20	20
Corn meal,	2	2
Shorts,	2	
Gluten,	2	3½
Milk per day,	18.71	19.47
Dry matter in ration,	15.49	15.41
Nutritive ratio,	1 : 7.6	1 : 7.2

As in the last case the cost of these two rations is the same, but it will be seen that the gluten is the more efficient, and this, too, against the natural shrinkage of the yield, for in each case the gluten was fed last.

The change in nutritive ratio is not great, but it will be noticed that the results, so far as they go, would seem to indicate

that the middlings and shorts rations, with a ratio of 8.4 and 7.6, respectively, were too wide, and that narrowing them to 7.7 and 7.2, though not a great change, is, nevertheless, one that has resulted in a considerable increase of milk, and we may well ask the question whether we can afford to go beyond 7 as the widest limit. I am inclined to think that we cannot.

In conclusion, then, the following conclusions may be drawn:

First. That with rations, whose nutritive ratio is below 1 : 7, it makes very little difference whether we use cotton seed, shorts, middlings or corn meal, so far as milk is concerned, but if we consider the value of the manure the grains will be valued in the order in which they stand.

Second. When the nutritive ratio is wider than 1 : 7.5 a substantial gain may be expected by substituting some grain that will narrow this ration.

Third. A nutritive ration of 1 : 7 is as wide as we can profitably use.

I am convinced from these, and other experiments, that the *proportion and amount* of digestible constituents in the ration is of more importance than the *source* of these constituents, and that the cost of the grain must be the factor that will influence the feeder.

Once more let me urge every farmer to note what he is feeding, both in kind and amount, and then from table II compute the digestible nutritive matter consumed daily and compare this with table I. If it is found that the ratio of non albuminoids to albuminoids is very wide, that is, over 7.5, then a few easily made experiments, in which either cotton seed, gluten, middlings or shorts is substituted for corn meal, will enable any one to determine whether a closer following of the German "standards" will be profitable. There can be no loss result from testing this important matter, and valuable information may be obtained.

G. H. WHITCHER, *Director.*

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